Starting a Lab Facility:

A Primer for Developers, Investors and Real Estate Professionals

BAM Creative

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Acorda Therapeutics, Ardsley, New York | Architect: BAM Creative | Photography © Albert Vecerka | Esto

The scientific research market has grown substantially over the last ten years. With a global pandemic in front of mind, investors are looking at the life science industry now more than ever. This expanding market is evolving into one of the fastest-growing real estate investment sectors, yet some developers, investors, and real estate professionals may be intimidated or confused by the myriad of complexities in site selection, design, and construction of lab facilities.

Familiarity with industry-related terms and a basic understanding of what is needed to develop a successful lab research facility are key starting points.

Scientific research requires an appropriate environment to conduct experiments, process data, foster collaboration, and inspire creativity. Proximity to potential clients and talent, availability of public transportation, tax incentives, zoning restrictions, and surrounding neighborhoods are intrinsic traits that need to be considered when finding a suitable location to build a project. The configuration of the space can be adaptable to accommodate unknown needs of the program, a future tenant, or can be targeted towards a specific type of science.

One constant in science is that it is continuously evolving. The needs within the research laboratory will change over time. The combination of science and tech is propelling the productivity of the industry thus increasing the need for more adaptable space types. Starting and operating a lab facility requires decoding the scientific research market, understanding the needs of the industry, selecting a location, and developing a space that will foster research, creativity, and growth.

Types of Labs

Scientific research encompasses a wide range of disciplines requiring specifically designed environments to achieve success. Adaptability in a lab space is achievable but it comes with financial and space implications. Advanced knowledge of the type of science and research being conducted allows for a targeted design process to create an efficient space that satisfies the program needs while allowing for future growth. Understanding the types of lab spaces used to conduct the research is important when selecting a location for a client. Typically, research laboratory spaces can be divided into wet and dry lab components. In addition, there are more specialty wet lab environments such as BSL (Bio Safety Level) labs, vivariums, and clean rooms. Modern technology in the lab, as seen in computational rooms and robotic automation, is also continuing to play a larger role in research spaces.

T-Cure Bioscience, Los Angeles, California | Architect: BAM Creative | Photography © BAM Creative

Wet Lab Spaces

Chemical and biological matter is analyzed in wet labs, to develop drugs and therapies. They require power, water, direct ventilation, and often specialized piped utilities and gases. Wet labs are typically divided into separate laboratory modules that have individually controlled connections to HVAC, utilities, and safety equipment. With wet laboratory space, there is often the need for accompanying laboratory support rooms, which may house equipment with requirements that differ from those in the open lab.[1]

Dry Lab Spaces

Dry laboratory space types are defined as laboratories that work with dry stored materials, electronics and/or large instruments with few piped services. Dry laboratories typically do not have plumbing, and do not allow chemical or biological materials in the space. As a result, they may have fewer restrictions regarding air pressurization, gowning and security. Often these spaces are analytical laboratories that focus on computational research, which may require temperature, dust, and humidity controls. Dry laboratory spaces can have less stringent requirements for outdoor air and exhaust which can make them less costly to construct and operate, however constructing the space this way can limit their flexibility for future use.[2]

Biosafety Labs (BSL's)

Biosafety labs (BSL's) are a type of wet research lab space used to study infectious substances. The labs must be designed to ensure the end user's safety. There are four biosafety levels that categorize laboratory practices, safety equipment and design, based on the research being conducted. BSL-1 contains the least hazardous materials, while BSL-4 contains the most hazardous materials.

Vivariums

Vivariums are highly controlled animal research facilities. They require specialized, dedicated mechanical systems to eliminate external pathogens. The need for a sterile environment also dictates the usage of gowning vestibules with air pressurization to assure infection control within the facility. Direct circulation of people, animals, supplies, and waste is necessary to provide a controlled environment. Animal research is sensitive and special attention to security and confidentiality are important considerations in the design of these facilities. Vivariums, and the animals within, require continuous maintenance and monitoring without disruption or downtime.[3]

Clean Rooms

Clean rooms provide a hyper-controlled environment for research and can be custom built or manufactured to fit into an existing space. Large volumes of air are supplied through filters to reduce particulates. Cleanroom cleanliness is defined by the ISO 14644-1 standard and ranges from ISO Class 1 (the cleanest) to ISO Class 9 (least clean). Typical open lab space is considered ISO 9, and the the majority of clean room spaces are ISO 7. They require continuous flooring, integral coved base, and cleanable walls and ceilings, as well as personnel measures to ensure contaminants do not enter the space.

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[1] *National Institute of Building Sciences. "Laboratory: Wet". 02-04-2019.*

[2] *National Institute of Building Sciences. "Laboratory: Dry". 01-23-2019.*

[3] *Stark, Stanley, F.A.I.A., James Petitto, R.A., Steven Darr, P.E. HLW International LLP. Whole Building Design Guide: Animal Research Facility. 05-15-2017.*

Computational Labs

Computational labs facilitate the use of computers to perform scientific research and data analysis. High performance computing includes many scientific disciplines and may require intricate IT coordination, backup power, and specialized temperature and humidity controls to support the research. Data scientists have become vital to the research industry and the configuration of scientific research environments has shifted to a combination of wet labs, flex labs, and computational labs.[4]

Northwell Health, Lake Success, New York | Engineer: WSP | Photography © Edward Caruso

Ideal Locations

In the United States, the scientific research industry spans from coast to coast but the successful hubs thrive off centralized resources that provide an ideal environment for the industry. These hubs are often situated near highly ranked educational institutions that produce successful research and large numbers of graduates in sciences. Often nearby there are award-winning hospitals and leading academic medical facilities. Hubs may also be in the vicinity of pharmaceutical and bioscience companies that attract populations into the workforce, as well as established lab spaces.

Transportation and accessibility are also key factors when considering location. Research labs require access to

[4] *JLL. 2020 Life Sciences Real Estate Outlook.*

multiple modes of transportation, ample parking space for staff, maintenance personnel, and delivery traffic. The facility should provide easy access for couriers and other transport services, to pick up and deliver specimens. In cases of medical or chemical emergencies, it is important that the lab is easily accessed by ambulances, fire departments, and poison control.

The increased market growth in urban centers has unique concerns for available space and space types. While new construction may be effective in less urbanized regions, leasing may prove to be a more economical option, particularly with developing companies and sectors. It allows smaller companies to become established in well-known research clusters without the time and cost commitment of constructing a new facility. Leased spaces can also be negotiated for shorter periods, giving companies more flexibility in the growing research market.[5] Incubator configurations, with laboratory space and access to a shared laboratory services such as fume hoods, freezers, and biosafety cabinets are a growing alternative option for smaller start-ups, which allow for shared expenses, and a more affordable operation.

Lake Nona Life Sciences, GuideWell Innovation Center, Lake Nona, Florida | Architect: BAM Creative | Photography © BAM Creative

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[5] Shelow, Taitia. Leasing of Research Facilities Becoming More Prevalent in Coveted Urban Areas Careful Evaluation, Negotiation Needed to Ensure a Beneficial Arrangement Published. 1-22-2014.

Zoning and Location Considerations

Zoning regulations differ from city to city but confirming the building is within the correct zoning code is critical at the beginning of the planning process. Typically, cities that support life sciences have appropriate zoning regulations for bio-medical facilities to be in manufacturing and light industrial districts, depending on the type of facility and its chemical and biohazard maintenance.

However, cities like New York City and Los Angeles, with a blend of mixed-use buildings and dense land-use, have been working to create unique specialty districts to further efforts to become life-science clusters that will generate a larger workforce and increase capital.

Zoning regulations may include minimum distances from residential and educational buildings, and traffic congestion measures. However, as zoning districts vary with each locality, they also contain different code requirements. Research laboratories are required to adhere to strict regulations and standards. Laboratory design, construction, and renovation are regulated by state and local laws that incorporate standard practices in various uniform codes, such as the International Building Code (IBC), the International Fire Code (IFC), and the National Fire Protection Association standards (NFPA), OSHA, ANSI and ASHRAE. Building and fire codes are enforced by the fire authority having jurisdiction, which is typically the local fire marshal.[6]

HATCHlabs, Los Angeles, California | Architect: BAM Creative | Photography © Nirav Solanki Photography

[6] *National Academies of Science, Engineering, and Medicine. Laboratory Design, Construction, and Renovation: Participants, Process, and Product. Chapter 3. Page 61. 2000.*

State and federal regulations typically incorporate various codes and consensus standards. Code requirements to keep in mind are ventilation, fire prevention, standby (backup) power supply, quantities of hazardous gases and materials, building heights and setbacks, and seismic requirements where necessary. It is important to check local codes, as states and localities have their own specific differences.

When determining whether to build a new space or renovate an existing space, it is important to keep in mind that new buildings allow the team to design and build without running into unforeseen issues caused by existing infrastructure. Although some utilities and infrastructure may be reused in an existing space, additional effort is often required. For instance, shaft penetrations in a new space can be placed where needed, but in a renovation space, the existing shafts may not work with the new program.

Also, research may not be suitable on certain floors of a building without extensive upgrades because minor vibrations, that typically go unnoticed, may negatively impact the research being conducted. In an existing space, costs of demolition, adaptability of an existing layout, and infrastructure need to be considered.

The design team should conduct a survey of existing conditions, with careful attention to hidden conditions which may impact the project. There is typically at least a 20% cost increase for renovation versus a new build due to additional infrastructure modifications to accommodate mechanical and electrical systems for the research. The cost can be significantly more than 20% if the space was not originally designed for scientific research or there are other factors like asbestos removal. It is important to keep a contingency for potential unknowns in a renovation project.

Like construction projects, building costs for research labs may vary significantly from region to region, depending on cost of labor and availability of materials. However, overall, the construction cost for a lab fit-out may be two to three times the cost of office construction. Specialty laboratories such as BSL, vivariums or clean rooms are typically at least five to six times the cost of an office construction fit out. The greatest contributor to lab costs is the infrastructure that is required to support a functional laboratory space, including complex mechanical and electrical systems that can account for approximately 50% of the cost of the project. These systems can have extensive lead times and are often purchased during early bid packages to help expedite construction schedules.

Assembling a Team

The team members required for constructing a scientific research lab consist of an architect, engineer, contractor, operations and marketing team, real estate broker, and developer. These team members will work to provide a scope that fulfils major MEP and structural requirements to support a code-compliant lab, as well as the marketing and communication necessary to attract end users. In addition, building support spaces such as lobbies, corridors, bathrooms, and amenities needs to be considered to make the space ready, and desirable, for potential tenants. When selecting a team, it is important that the players have experience with successful lab projects. Environmental, Health, and Safety (EHS) compliance is another aspect of research laboratory design that is essential for the functioning and safety of a lab space. EHS compliance is a series of laws, regulations, and workplace procedures put in place to protect the wellbeing of workers. Building a team designated to ensure the design of the lab that follows EHS guidelines is crucial. The EHS teams can also prepare Hazardous Materials Management Plans listing materials that will be stored and used on site and submit to the local fire department for their review and approval.

Planning and Designing Your Lab

Planning laboratory space is complex, particularly as the space needs evolve as the science evolves. Scientific discoveries expose new branches of research and it can be difficult to predict where the research will be. As a result, laboratory planning needs to factor in adaptability, and fully understand current trends and trajectories within the market. Regardless of the type of science being conducted, there are common approaches to lab design with key programming elements that can cover a range of research. Workflow, user needs, MEP requirements, safety, security, waste management, storage, and amenities are elements of the design that factor into the adaptability and function of the research space.

Irvine Company + University Lab Partners, Irvine, California | Architect: BAM Creative | Photography © University Lab Partners

Mechanical, electrical, and plumbing system infrastructure are critical components of creating a successful laboratory project. System selection will have large impacts on cost, flexibility, performance, and space within the building. With a known program, such as a single occupant new build, systems can be appropriately sized to meet the needs of the research and avoidance of oversizing, which becomes costly and inefficient to operate.

With an unknown program, such as in a developer spec lab building, or a building designed for multi-tenant use, varying programs, assumptions need to be made for appropriate air-change rates, capacity for chemical fume hoods, strategy for routing and placing tenant provided supplemental systems needing outdoor or roof space such as fans, process chillers, or back-up generators. These decisions should be made early in the design process with a clear plan of what utilities and services will be provided by the building owner, what will be provided by the tenant, and how the costs for these utilities and equipment maintenance will be divided.

It is typically more cost and energy-efficient to have a single large central HVAC and electrical infrastructure within a building as opposed to multiple smaller systems. Large systems provide better space efficiency by taking less of a footprint for equipment compared to multiple smaller pieces of equipment, more vertical efficiency by requiring fewer duct and pipe risers in a multi-floor building, higher energy efficiency accomplished by more efficient components, and operational efficiency by having fewer pieces of equipment to maintain.

Regeneron Pharmaceuticals, Tarrytown, New York | Architect: BAM Creative Photography © Albert Vecerka | Esto

One disadvantage of large central systems is that they often require an entire system to run, even when a small portion of the building may require a service, such as with a supplemental process cooling chiller. Laboratories using chemicals are required to be ventilated continuously, however other portions of the building occupancy may be able to shut down when not in use. They are also usually designed to best satisfy the general need for the building and may not be suited to a specific specialized need of a tenant, which would result in specialty equipment required to serve that need.

Profectus Biosciences, Tarrytown, New York | Architect: BAM Creative | Photography © Albert Vecerka | Esto

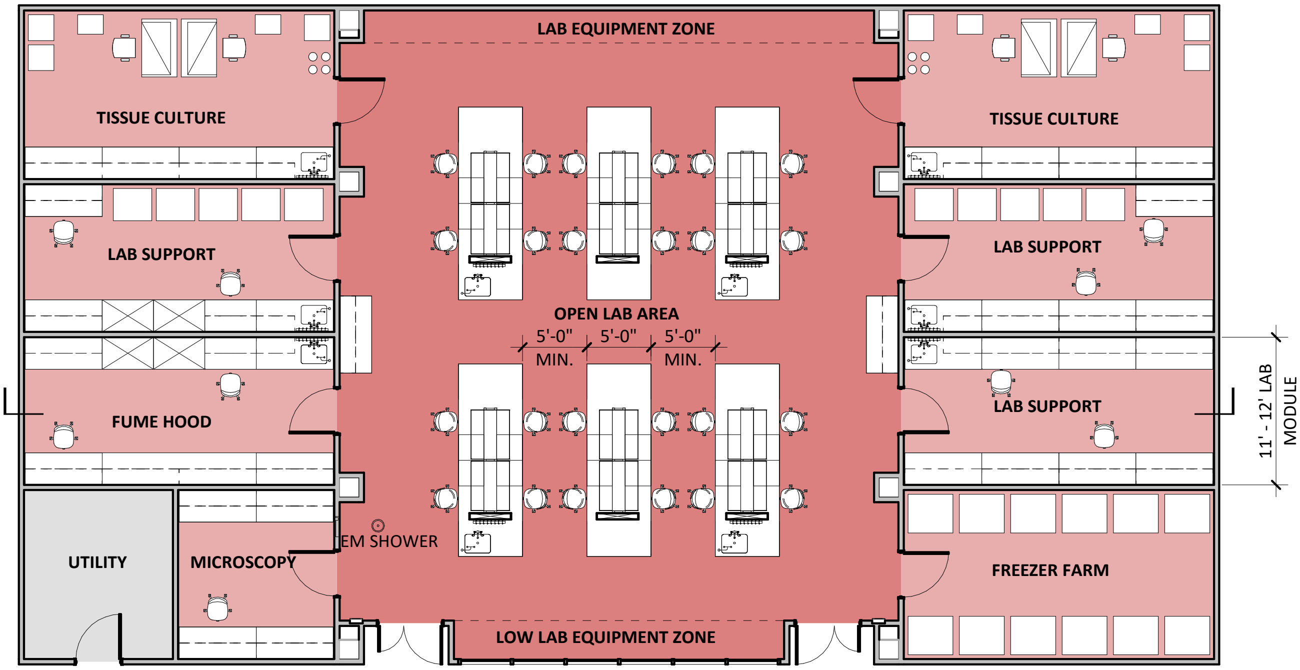
The size of casework, equipment, and MEP systems create specific spatial requirements for research laboratory spaces. Design issues to consider include framing depth and floor to floor height. The ceilings height in labs should be a minimum of 9'-0", and 10'-0" where possible. Mechanical and structural space above the ceiling typically require 4'-0" – 6'-0" of space, which results in a slab-to-slab height of 16'-0". Other building considerations include slab thickness, which affects the trenching of utilities, and column spacing, which impact lab casework and equipment layout.

T-Cure Bioscience, Los Angeles, California | Architect: BAM Creative | Photography © BAM Creative

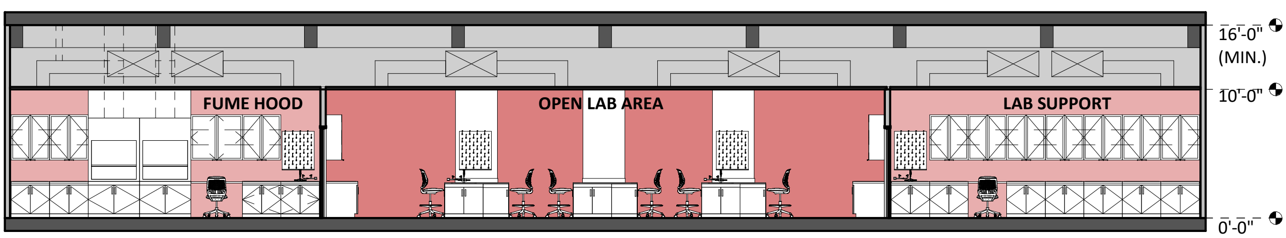
The correlation between lab space, support space, and corridors are a crucial factor that impacts the overall efficiency of a building. Incorporating a single corridor, two corridors, or a three-corridor layout will depend on the desired workflow. The type of research and experiments performed will determine the best use of space, whether the benches are located on the perimeter of the building maximizing daylight, or along the core of the building to access specific services. The use of natural light, utility access, equipment and instrument limitations are examples of the elements that need to be considered in the initial planning stages. Designing an adaptable lab space allows a tenant potential to reconfigure the space as needs change without having to undergo major renovations. The 11'-0" planning module is common across the industry. The savings on time and cost are beneficial to developers and tenants.

Research laboratories that adapt to the evolving changes in science with a technology-driven focus will future proof the research lab space. Digital technologies improve scientific workflow and innovation. By connecting multiple fields, automation improves the quality, efficiency, and safety of laboratory research.[7] Digital technology and automation components can be switched out more readily as opposed to traditional lab components thereby providing an environment that adjusts to the needs of the user without requiring major renovation of the space.

[7] *Lippi, Giuseppe and Giorgio Da Rin. Advantages and Limitations of Total Laboratory Automation: A Personal Overview. Clinical Chemistry and Laboratory Medicine: Volume 57: Issue 6. 02 Feb 2019.*



PLAN

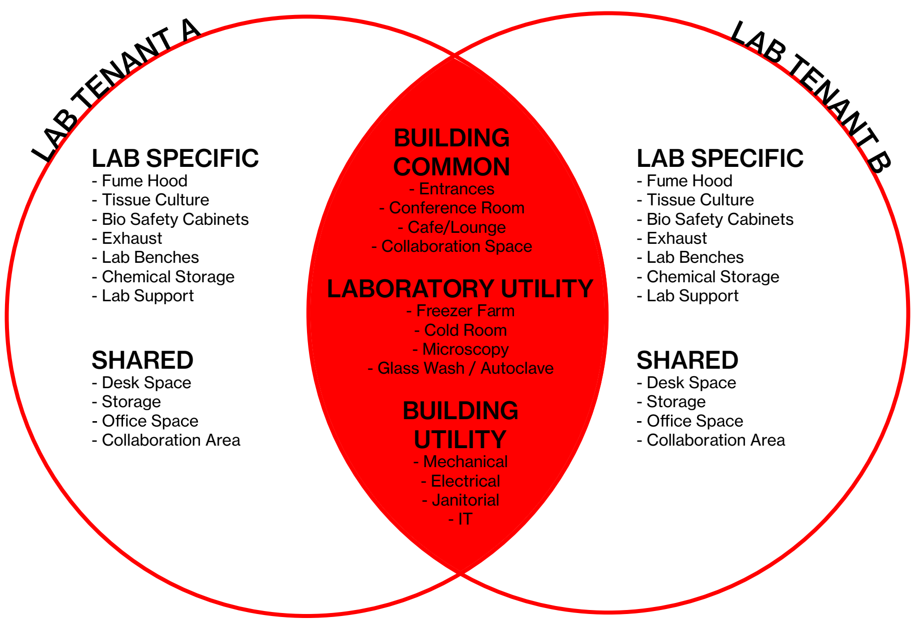


ELEVATION

Hypothetical Lab Layout

LEGEND

LAB SUPPORT   MECHANICAL   OPEN LAB AREA



Northwell Health, Queens, New York | Engineer: WSP
Photography © Edward Caruso

Safety concepts that are fundamental to research lab design include safe working zones, safety equipment, first aid stations, eyewashes at lab sinks, safety showers, availability and use of biological safety cabinets (BSC), fire extinguisher locations, air pressurization zones, and fume hoods for working with flammable and hazardous material. Safety showers are provided approximately every 100' to be used in the event of a chemical spill on a person. The water at safety showers and eyewashes must be tepid, often requiring a large hot water heater due to the high flow rate of water through the safety shower.

Research laboratories are spaces of competitive effort in discovery and are considered high security risk. It is important to consider the specific vulnerabilities of the work conducted in the facility to establish a security plan effective for protecting valuable equipment, specimens, chemicals, staff, and facilities. During early planning, security measures should be placed at building perimeters, primary, and secondary building entrances, access points at each department and sensitive areas such as storage, management offices, and waste management areas.

BioMed Realty Trust (Acquired by Blackstone), One Research Way, Princeton, New Jersey | Architect: BAM Creative | Photography © Charles Uniatowski

Loading and delivery spaces should be placed strategically throughout the facility for easy access by all labs and workspaces. Storage planning can vary with each department having their own storage spaces with appropriate locks, or other forms of restricted access. Multiple storage closets may be needed to separate equipment or substances that cannot commingle with others or need specialized temperature and ventilation requirements. Open storage solutions such as shelving and metro carts allow for quick access inside labs, while locked cabinets and closets maintain security when spaces are vacant.

Planning for waste management can vary depending on the type of research being conducted. If off-site management is needed, the lab needs to be located an appropriate distance from the treatment facility. If considering a lab without central accumulation areas, there should be multiple hazardous containers placed close to working areas in all labs for quick transfer of hazardous materials without cross contaminating waste.

Institutions with central disposal centers must prepare for the commingling of waste. These centers require safe spaces that will not create explosive conditions. Electrical systems should be non-explosive, and floors and containers should be conductive, grounded, and bonded. Ventilation systems require appropriate customization, along with the utilization of fume hoods for sorting waste, appropriate fire systems, and sewage considerations to prevent contamination in case of spills.

Hazardous materials are produced and used in research laboratories, and their removal and remediation can be costly. Current environmental regulations state that a property owner will be held liable for the release of contamination caused by its tenant under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Property owners should therefore expect tenants to confirm compliance with the policies and guidelines of all applicable environmental agencies.[8]

Regeneron Pharmaceuticals, Tarrytown, New York | Architect: BAM Creative | Photography © Albert Vecerka | Esto

[8] Duberman, James. Key Issues in Commercial Real Estate Leases for Life Sciences Tenants. 04-09-2019.

Space Types

Property owners can meet the demand for research space, by providing laboratories on "spec". The design of these types of labs assumes a typical program based on an understanding of the market and typical needs while understanding there is a level of risk that some customizing will be required once a tenant is confirmed. Some companies are growing faster than construction can keep up with; facilities built on spec can fill the need for an immediate furnished space.

If providing multi-tenant space, property owners need to consider providing amenity spaces to attract new tenants. Open collaboration zones, terraces, outdoor gathering space, as well as opportunities for public dialog through gathering and small auditorium spaces are highly desired amenity spaces. Common eating areas and barista zones may also provide a backdrop for cross-collaboration between tenants. The ratio of collaborative space to the office/administrative zone is approaching a ratio of 3:4.

The potential program within the research zone must also be considered. The ratio of lab/lab support space versus office/administrative space typically hovers around 1:1, although the ratio can range from 2:3 to 3:2. Within the lab zone, the typical ratio of open lab space versus lab support space is 3:2. The ratio depends on the type of scientific research being conducted and the business strategy of the tenant, but current trends in specialty research will increase the need for lab support space.

T-Cure Bioscience, Los Angeles, California | Architect: BAM Creative | Photography © BAM Creative

Understanding the economics of prospective tenants is also a key factor for developers and property owners when determining types of spaces to offer. Property owners can provide the infrastructure for some services that tenants cannot afford to build, or they can specifically build out these spaces and offer them as amenities to the tenant. These types of amenities can be offered in a communal area, at the back of the house, near the core or cellar or potentially near a freight elevator. Amenity spaces are often away from windows as tenants typically look to occupy well well-lit, open space with access to natural light and exterior views.

Conclusion

The rapid growth of the scientific research industry has accelerated the demand for research laboratories in hubs across the country. Although the research conducted and size of facilities vary, adaptability of space is paramount to the success and function of a research lab in a constantly evolving industry. Research lab facilities inherently require more time and resources to develop compared to commercial projects, however the contribution to the industry and the potential for multi-tenant success are drivers for the investment being made across the country. Starting a research lab facility requires careful consideration during the initial stages of development in selecting a location, building a team, and applying sound principles of laboratory planning to create efficient research and development buildings that can support, and inspire, the scientific community for years to come.

Lab Building Matrix

Building Type	Office Building	Laboratory Building
Typical Zoning	Most Commercial and Mixed Use Districts	Limited to specific zones, depends on local regulations. Examples: In New York City: C2, C4, C5, C6, C8, M1, M2, M3 In Los Angeles: CM, MR1, M1, MR2, M2, M3
Maximum Building Height	Limited based on local zoning only.	Typical Maximum 4-6 stories, depending on local zoning, hazardous chemical usage, shaft limitations.
Slab-to-Slab Building Heights	13’-14’	15’-16’ Preferred
Structural Column Spacing	Varies	Columns typically at 22’ or 33’ Intervals to Support 11’ Lab module
HVAC Airflow (CFM/Sqft)	1.0-1.5 (CFM/Square feet)	1.5 - 2.5 (CFM/Square feet)
Typical HVAC Ventilation Strategy	Recirculating VAV with Economizer, plenum return	Once-through ventilation, ducted supply and exhaust
Typical Mechanical Cooling Load	250-300 Square fee/ton	150-250 Square feet/ton
Electrical Design Power Density (W/sqft) - Excluding Mechanical	5-7 (W/Sqft)	15-30 (W/sqft)
Electrical Generator Sizing	Life Safety Only	Life Safety, Fume Hood Exhaust +Make-Up Air, Critical Scientific Equipment, Building Heating and Partial Cooling.
Plumbing Waste	Sanitary	Sanitary and Acid Waste
Plumbing Water	Cold, Hot, Hot Water Return	Cold, Hot, Hot Water Return, RO or RO/DI
Plumbing Gases (non-heating)	None	Compressed Air, Vacuum, Nitrogen, CO2

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